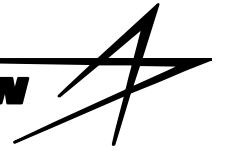


LOCKHEED MARTIN



Mobile Agents for the Military



**Advanced Technology
Laboratories**



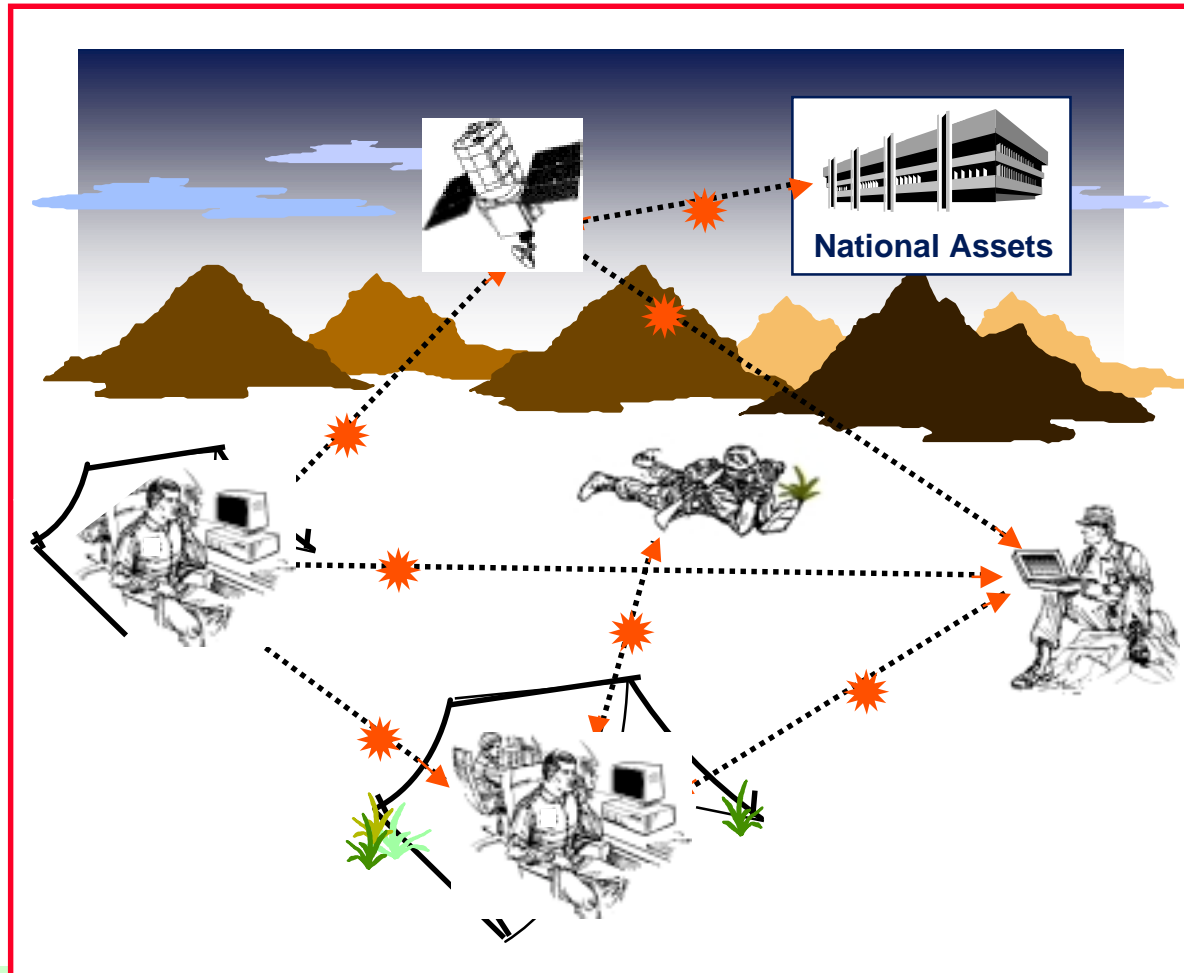
Evolving an “Information Agent” Development Kit



- Example C4ISR agent applications
- A general class of information agents: Push, Pull, Sentinel
- Extended Mobile Agent Architecture (EMAA): A Development Kit for Information Agent Applications
- How do you adapt it to a new application?
- Assessment

A Strategy for Transitioning Agent Technology

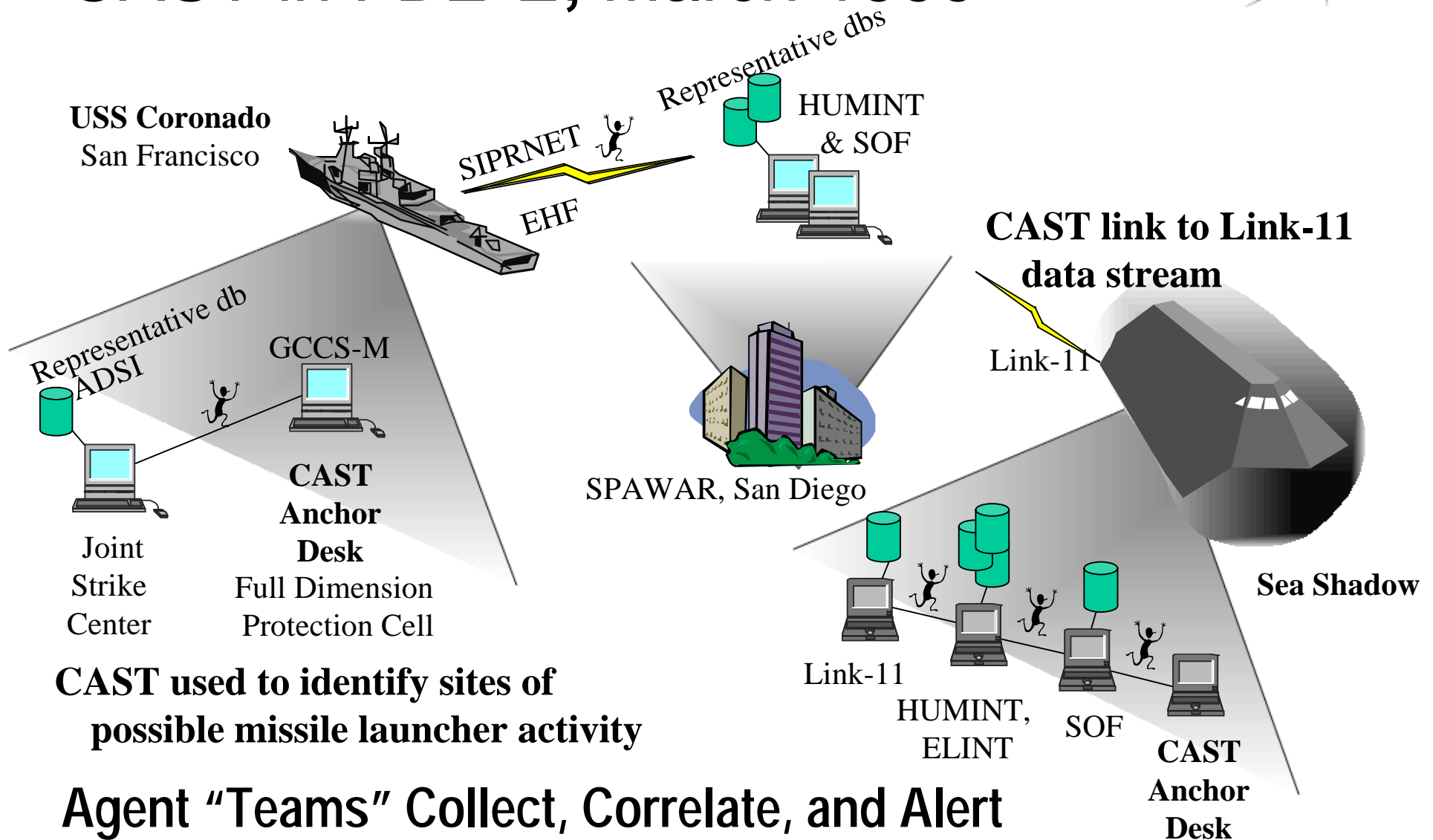
Domain Adaptive Information Systems (DAIS)



- Apply intelligent agents to battlefield intelligence collection and analysis
- Agents locate and query databases
- Agents deliver data over unreliable networks
- Participated in 13 field exercises
- Deployed a series of leave-behind systems
- Routine operation by US Army 201st MI BDE

- Autonomy and persistence of mobile agents is crucial in low bandwidth, unreliable networks.
- “Task and Forget” capabilities enhance operator performance.
- Agent-mediated query makes heterogeneous databases accessible to all users.

CAST in FBE-E, March 1999



CAST used to identify sites of possible missile launcher activity

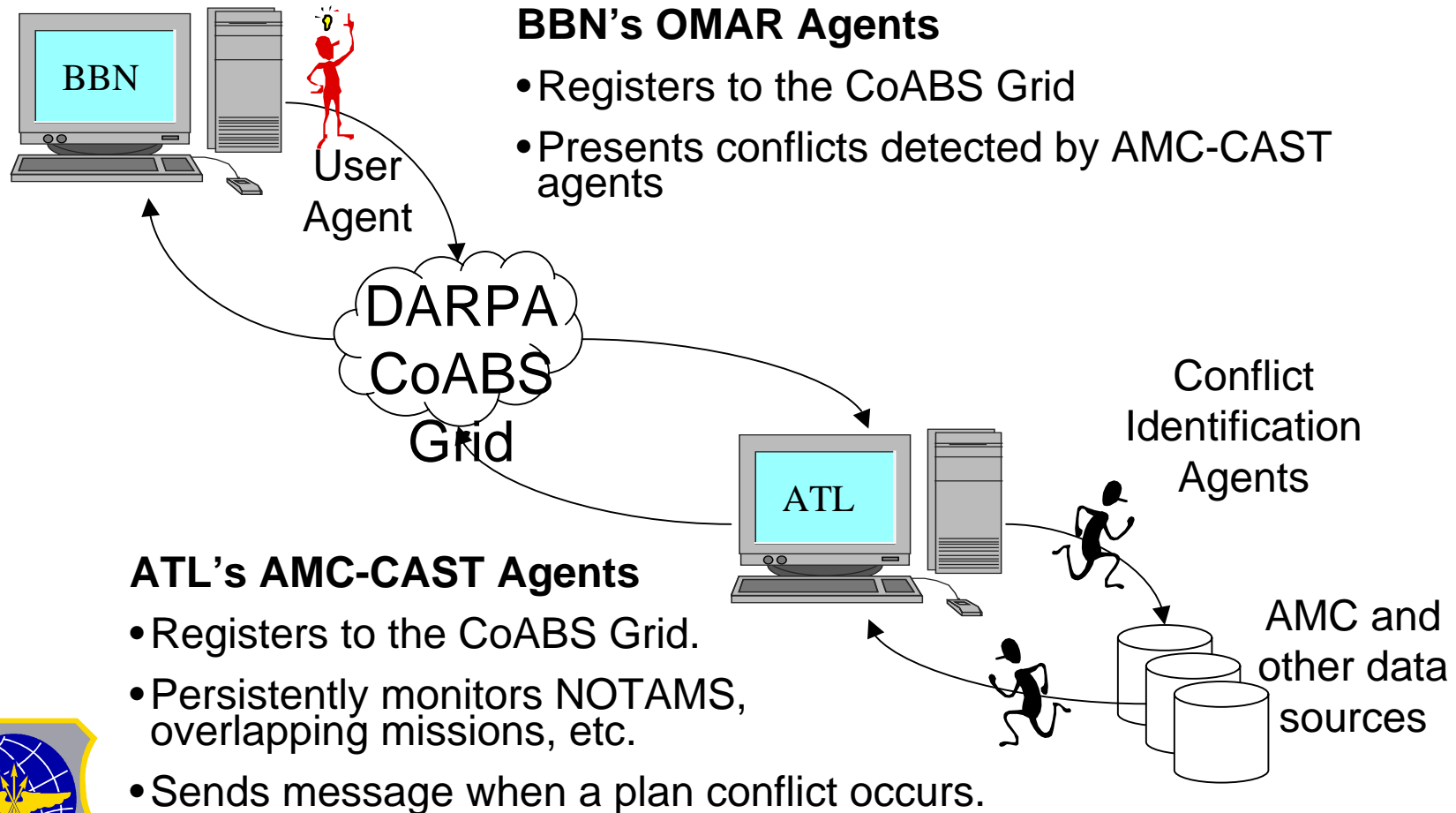
Agent "Teams" Collect, Correlate, and Alert on Possible Time-Critical Targets



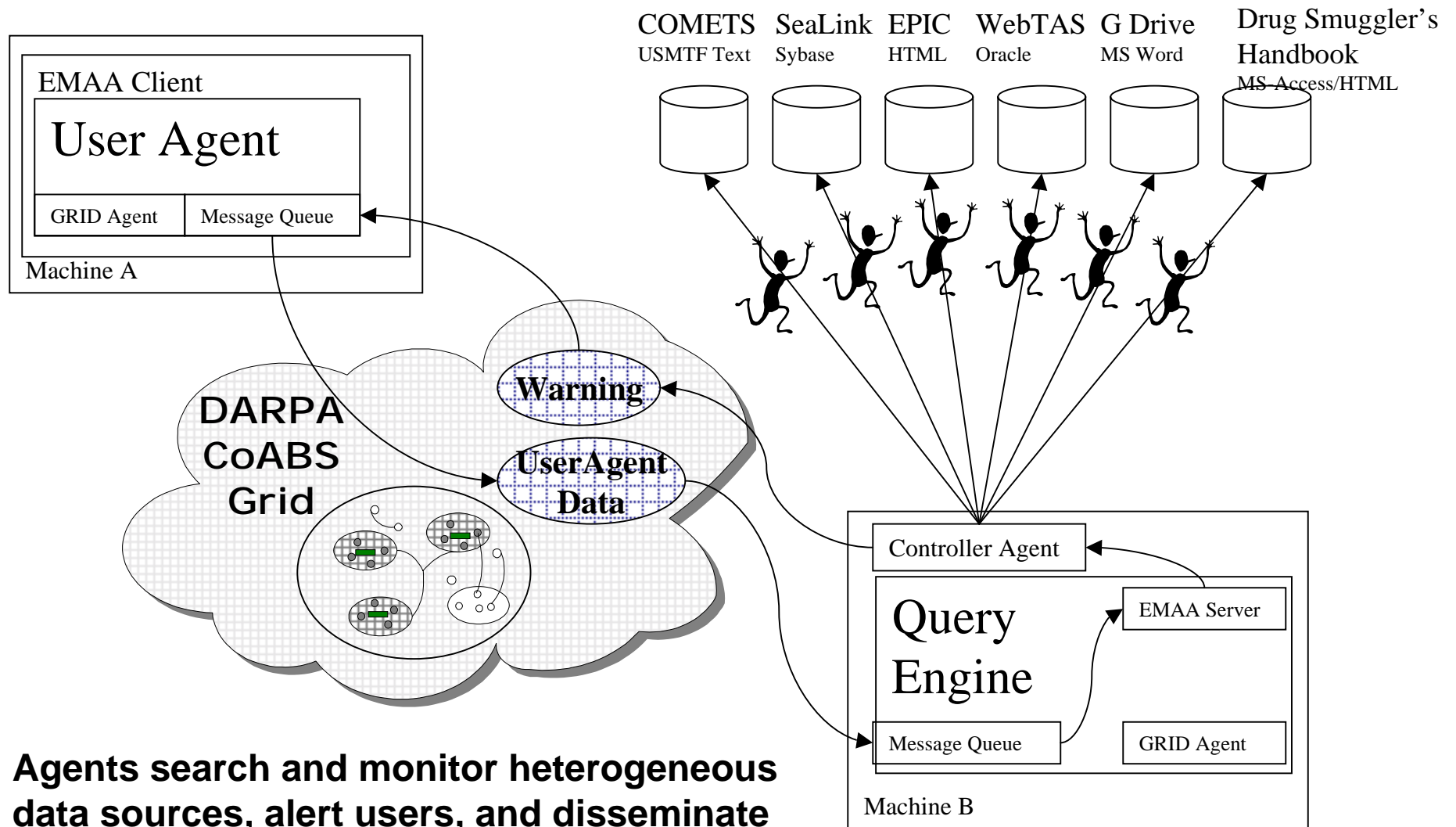
Air Force Air Mobility Command Mission Planning Support



ATL & BBN Agents Identify Conflicts on Behalf of the AMC Planner



Joint Inter-Agency Taskforce (JIATF-E)



Agents search and monitor heterogeneous data sources, alert users, and disseminate information



Push, Pull, and Sentinel Agents

Lessons learned in 14 agent projects point to three basic information functions: dissemination, discovery, and “sentinel”

Push - Information Dissemination

- Assured “task & forget” information delivery
- Intelligent selection of recipients

Pull - Information Discovery

- “Power-assist” for users’ information search
- Agents integrate information from disparate sources

Sentinels - Information Analysis

- Collect data, give user interpretation

Agents reduce work and accelerate decisions



Sentinel Agents

Requires combination of capabilities: **Information Correlation**

- Based on domain criteria, e.g. co-location

Assessment and Interpretation

- Based on criteria such as threat taxonomy and fuzzy decision rules

Information Need Anticipation

- Based on task profiles

Relies on: non-agent functions, e.g., sensor and track fusion, non-cooperative target ID

**Three fundamental capabilities support
timely, focused information flow**

Information Agents and Mobility



Agents can be

Static (Agent resides on one network node regardless of where required inputs reside or outputs belong)

Or

Mobile (Agent migrates among nodes performing tasks at nodes that contain inputs or require outputs)

For C2 networks, information distribution and network unreliability favor combining mobile and static agents

An Agent Application Development Kit



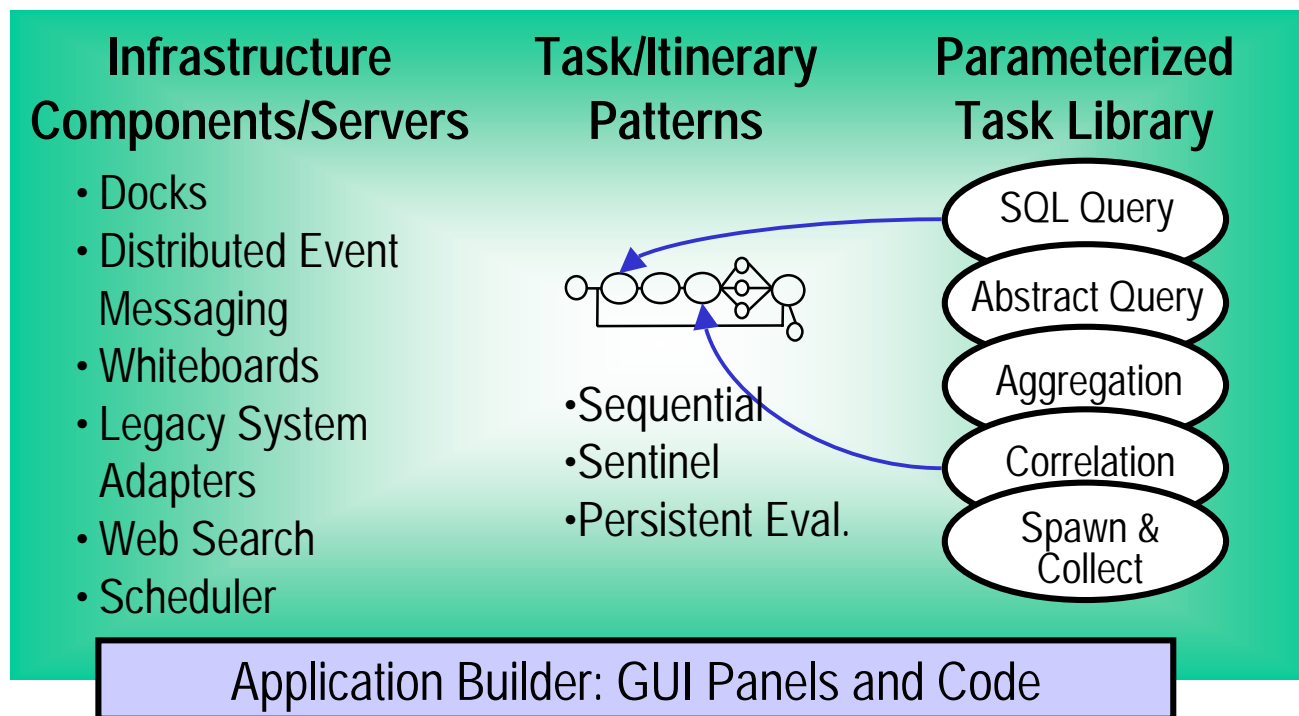
- Speed Development of agent applications
- Enable reuse and generalization of agents
- Provide services and functions that agents can (re)use
- Incorporate and exploit mobility features

Concept: Ubiquitous Push-Pull-Sentinel Applications

Development Kit Overview



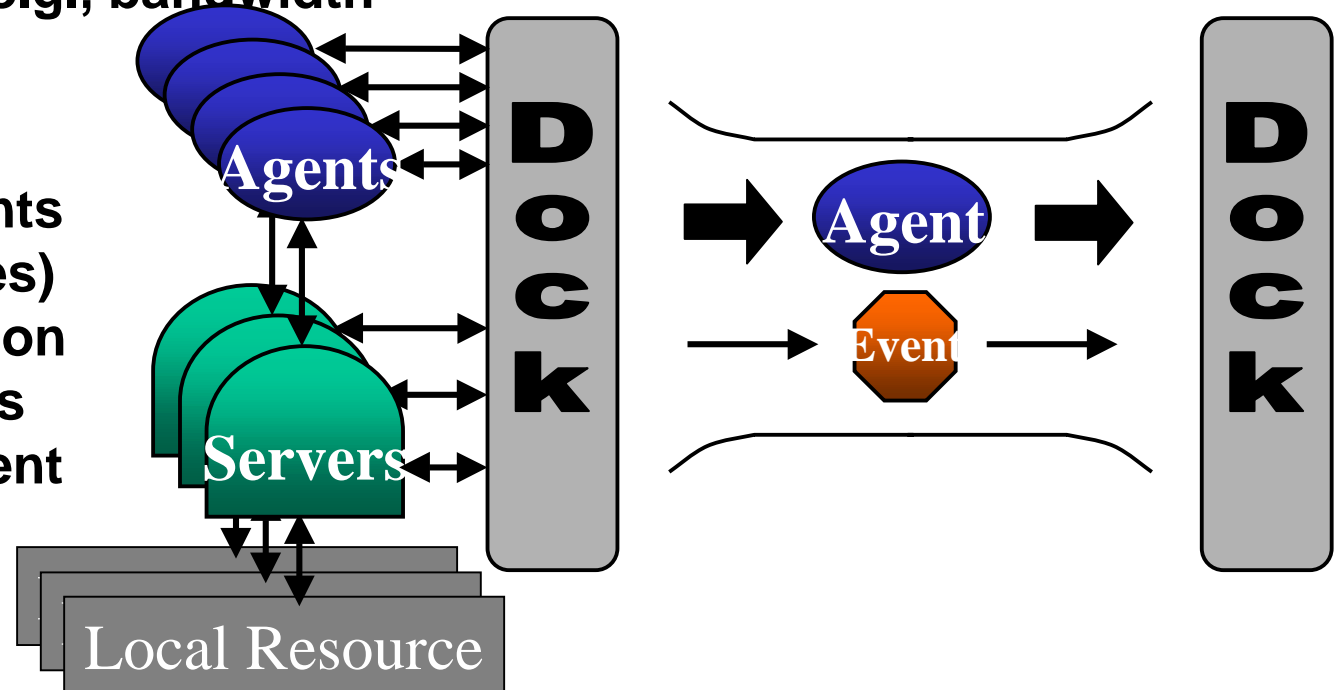
EMAA: ATL's Intelligent Agent Technology Development Kit



Agent Application Infrastructure



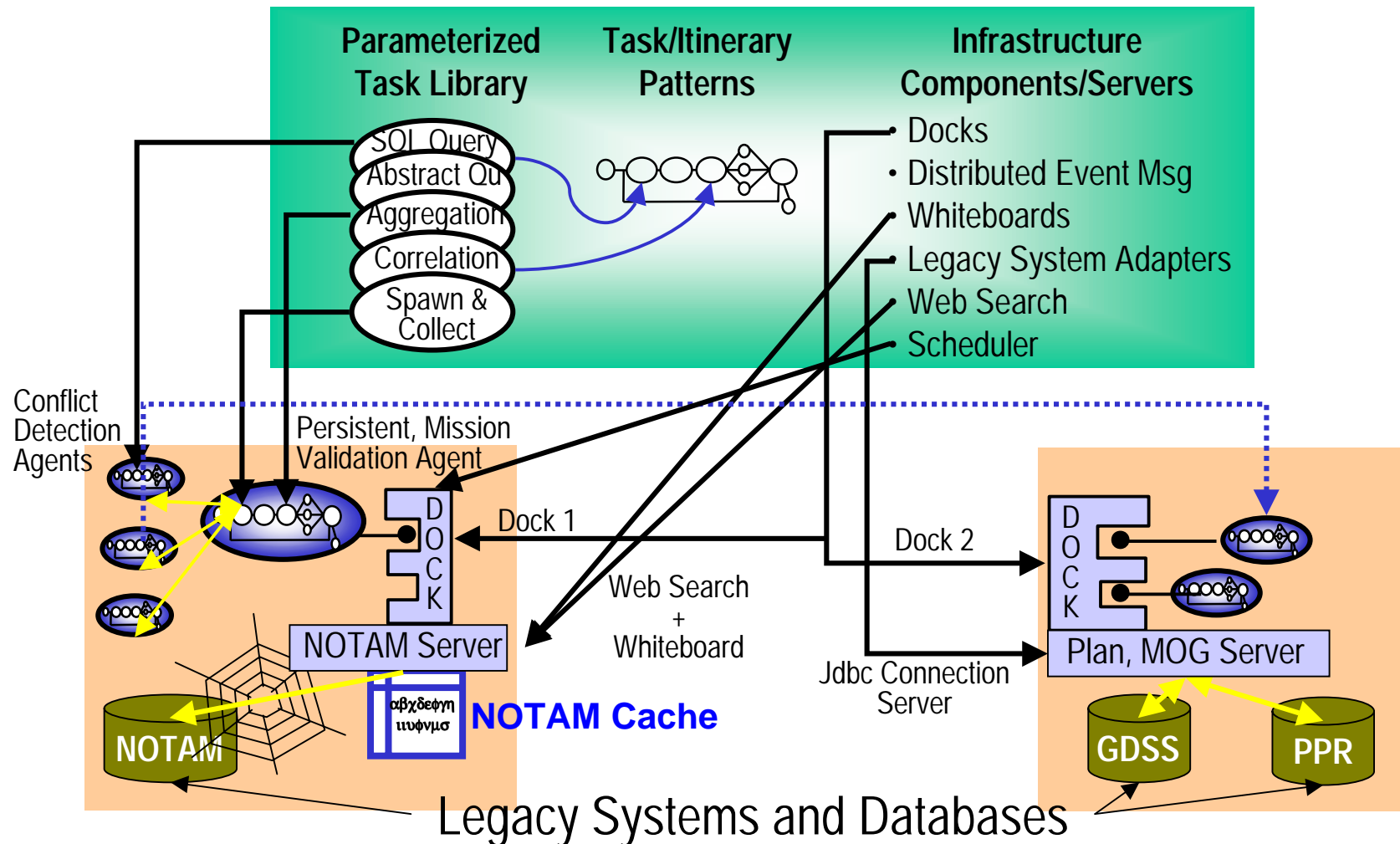
- Agent docks reside on network nodes and manage agents
- Agents cooperate, are persistent, taskable
- Mobile agents can select execution host to optimize performance, e.g., bandwidth
- Docks authenticate incoming agents (signed classes)
- Class loading on demand makes mobility efficient



Development Kit Example



AMC Plan Monitoring: Detect Plan Conflicts



Estimated Time Savings up to 40%



Assessment

- We have collected evidence of reduced time and cost
- Some remaining issues:
 - Connecting to data sources, etc. is still expensive
 - Cost could be reduced by the Grid
 - Kit still requires trained developer
 - Improved packaging of agent functions and agent execution infrastructure should reduce developer skill requirements

Summary



Building the Base for rapid development of agent-based applications:

- Proven in many C4I applications
- Participation in large exercises and demonstrations
- Fielded with military operators
- Crystallizing Into Re-usable Kit of Components

**One Strategy to Exploit Promise
of Agent Technology**